

**CPC****COOPERATIVE PATENT CLASSIFICATION****C21D****MODIFYING THE PHYSICAL STRUCTURE OF FERROUS METALS; GENERAL DEVICES FOR HEAT TREATMENT OF FERROUS OR NON-FERROUS METALS OR ALLOYS; MAKING METAL MALLEABLE BY DECARBURISATION, TEMPERING OR OTHER TREATMENTS**

(cementation by diffusion processes C23C; surface treatment of metallic material involving at least one process provided for in class C23 and at least one process covered by this subclass, [C23F 17/00](#); unidirectional solidification of eutectic materials or unidirectional demixing of eutectoid materials C30B)

**C21D 1/00**

**General methods or devices for heat treatments, e.g. annealing, hardening, quenching, tempering** (furnaces in general [F27](#); electric heating per se [H05B](#))

## C21D 1/02

- . Hardening articles or materials formed by forging or rolling, with no further heating beyond that required for the formation

## C21D 1/04

- . with simultaneous application of supersonic waves, magnetic or electric fields

## C21D 1/06

- . Surface hardening

## C21D 1/08

- .. with flames

## C21D 1/09

- .. by direct application of electrical or wave energy; by particle radiation

## C21D 1/10

- ... by electric induction

## C21D 1/18

- . Hardening ([C21D 1/02](#) takes precedence); Quenching with or without subsequent tempering ([quenching devices C21D 1/62](#))

## C21D 1/185

- .. {from an intercritical temperature}

## C21D 1/19

- .. by interrupted quenching

## C21D 1/20

- ... Isothermal quenching, e.g. bainitic hardening

## C21D 1/22

- ... Martempering

## C21D 1/25

- .. Hardening, combined with annealing between 300 degrees Celsius and 600 degrees Celsius, i.e. heat refining ("Vergüten")

## C21D 1/26

- . Methods of annealing

## C21D 1/28

- .. Normalising

## C21D 1/30

- .. Stress-relieving

## C21D 1/32

- .. Soft annealing, e.g. spheroidising

## C21D 1/34

- . Methods of heating ([C21D 1/06](#) takes precedence)

## C21D 1/38

- .. Heating by cathodic discharges

## C21D 1/40

- .. Direct resistance heating

## C21D 1/42

- .. Induction heating

## C21D 1/44

- .. in heat-treatment baths

## C21D 1/46

- ... Salt baths

- C21D 1/48 . . . Metal baths
- C21D 1/50 . . . Oil baths
- C21D 1/52 . . with flames
- C21D 1/53 . . Heating in fluidised beds
  
- C21D 1/54 . Determining when the hardening temperature has been reached by measurement of magnetic or electrical properties
  
- C21D 1/55 . Hardenability tests, e.g. end-quench tests ([investigating chemical or physical properties of materials in general G01N](#))
  
- C21D 1/56 . characterised by the quenching agents
- C21D 1/58 . . Oils
- C21D 1/60 . . Aqueous agents
- C21D 1/607 . . Molten salts
- C21D 1/613 . . Gases; Liquefied or solidified normally gaseous material
  
- C21D 1/62 . Quenching devices
- C21D 1/63 . . for bath quenching
- C21D 1/64 . . . with circulating liquids ([in general F28D](#))
- C21D 1/667 . . for spray quenching
- C21D 1/673 . . for die quenching
  
- C21D 1/68 . Temporary coatings or embedding materials applied before or during heat treatment
- C21D 1/70 . . while heating or quenching
- C21D 1/72 . . during chemical change of surfaces
  
- C21D 1/74 . Methods of treatment in inert gas, controlled atmosphere, vacuum, or pulverulent material ([production of gases C01, C10](#))
- C21D 1/76 . . Adjusting the composition of the atmosphere
- C21D 1/763 . . . {[using a catalyst](#)}
- C21D 1/767 . . with forced gas circulation; Reheating thereof
- C21D 1/773 . . under reduced pressure or vacuum
  
- C21D 1/78 . Combined heat-treatments not provided for above
- C21D 1/785 . . {[Thermocycling](#)}
  
- C21D 1/82 . Descaling by thermal stresses ([mechanically B21, B23](#); [chemically C23](#); [electrolytically C25F](#))
  
- C21D 1/84 . Controlled slow cooling ([cooling-beds for metal rolling B21B 43/00](#))
  
- C21D 3/00** **Diffusion processes for extraction of non-metals; Furnaces therefor** ([local protective coatings C21D 1/72](#); [furnaces in general F27](#))
  
- C21D 3/02 . Extraction of non-metals
- C21D 3/04 . . Decarburising

- C21D 3/06 .. Extraction of hydrogen
- C21D 3/08 .. Extraction of nitrogen
- C21D 3/10 . Furnaces therefor

#### **C21D 5/00 Heat treatments of cast-iron**

- C21D 5/02 . improving the malleability of grey cast-iron
- C21D 5/04 . of white cast-iron
- C21D 5/06 .. Malleabilising
  - C21D 5/08 ... with oxidation of carbon
  - C21D 5/10 .... in gaseous agents
  - C21D 5/12 .... in solid agents
  - C21D 5/14 ... Graphitising
  - C21D 5/16 .... Packing agents

#### **C21D 6/00 Heat treatment of ferrous alloys**

- C21D 6/001 . {containing Ni ([C21D 6/004](#) takes precedence)}
- C21D 6/002 . {containing Cr ([C21D 6/004](#) takes precedence)}
- C21D 6/004 . {containing Cr and Ni}
- C21D 6/005 . {containing Mn}
- C21D 6/007 . {containing Co}
- C21D 6/008 . {containing Si}
- C21D 6/02 . Hardening by precipitation
- C21D 6/04 . Hardening by cooling below 0 degrees Celsius

#### **C21D 7/00 Modifying the physical properties of iron or steel by deformation ([apparatus for mechanical working of metal B21, B23, B24](#))**

- C21D 7/02 . by cold working
- C21D 7/04 .. of the surface
  - C21D 7/06 ... by shot-peening or the like
  - C21D 7/08 ... by burnishing or the like
  - C21D 7/10 .. of the whole cross-section, e.g. of concrete reinforcing bars
  - C21D 7/105 ... {of concrete reinforcing bars}
  - C21D 7/12 ... by expanding tubular bodies

C21D 7/13 . by hot working

**C21D 8/00** **Modifying the physical properties by deformation combined with, or followed by, heat treatment** (hardening articles or materials formed by forging or rolling with no further heating beyond that required for the formation [C21D 1/02](#))

C21D 8/005 . {of ferrous alloys ([C21D 8/02](#) to [C21D 8/12](#) take precedence)}

C21D 8/02 . during manufacturing of plates or strips ([C21D 8/12](#) takes precedence)

**NOTE**

[M21D](#) are added

C21D 8/0205 .. {of ferrous alloys}

C21D 8/021 .. {involving a particular fabrication or treatment of ingot or slab}

C21D 8/0215 ... {Rapid solidification; Thin strip casting}

C21D 8/0221 .. {characterised by the working steps}

C21D 8/0226 ... {Hot rolling}

C21D 8/0231 ... {Warm rolling}

C21D 8/0236 ... {Cold rolling}

C21D 8/0242 ... {Flattening; Dressing; Flexing}

C21D 8/0247 .. {characterised by the heat treatment}

C21D 8/0252 ... {with application of tension}

C21D 8/0257 ... {with diffusion of elements, e.g. decarburising, nitriding}

C21D 8/0263 ... {following hot rolling}

C21D 8/0268 ... {between cold rolling steps}

C21D 8/0273 ... {Final recrystallisation annealing}

C21D 8/0278 .. {involving a particular surface treatment ([C21D 8/0294](#) takes precedence)}

C21D 8/0284 ... {Application of a separating or insulating coating}

C21D 8/0289 ... {Application of a tension-inducing coating}

C21D 8/0294 .. {involving a localised treatment}

C21D 8/04 .. to produce plates or strips for deep-drawing

**NOTE**

[M21D](#) are added

C21D 8/0405 ... {of ferrous alloys}

C21D 8/041 .. {involving a particular fabrication or treatment of ingot or slab}

C21D 8/0415 .... {Rapid solidification; Thin strip casting}

C21D 8/0421 .. {characterised by the working steps}

C21D 8/0426 .... {Hot rolling}

C21D 8/0431 .... {Warm rolling}

C21D 8/0436 .... {Cold rolling}

|             |      |  |
|-------------|------|--|
| C21D 8/0442 | .... | {Flattening; Dressing; Flexing}  |
| C21D 8/0447 | ...  | {characterised by the heat treatment}  |
| C21D 8/0452 | .... | {with application of tension}  |
| C21D 8/0457 | .... | {with diffusion of elements, e.g. decarburising, nitriding}                                |
| C21D 8/0463 | .... | {following hot rolling}  |
| C21D 8/0468 | .... | {between cold rolling steps}   |
| C21D 8/0473 | .... | {Final recrystallisation annealing}  |
| C21D 8/0478 | ...  | {involving a particular surface treatment ( <a href="#">C21D 8/0494</a> takes precedence)} |
| C21D 8/0484 | .... | {Application of a separating or insulating coating}  |
| C21D 8/0489 | .... | {Application of a tension-inducing coating}  |
| C21D 8/0494 | ...  | {involving a localised treatment}  |

|            |    |                                       |
|------------|----|---------------------------------------|
| C21D 8/06  | .  | during manufacturing of rods or wires |
| C21D 8/065 | .. | {of ferrous alloys}                   |
| C21D 8/08  | .. | for concrete reinforcement            |

|            |    |  |
|------------|----|--|
| C21D 8/10  | .  | during manufacturing of tubular bodies |
| C21D 8/105 | .. | {of ferrous alloys}                    |

|           |   |  |
|-----------|---|--|
| C21D 8/12 | . | during manufacturing of articles with special electromagnetic properties |
|-----------|---|--|

#### NOTE

In this group classification is made according to the most important feature in one subgroup only; for other features indexing codes of [M21D](#) are added

|             |     |  |
|-------------|-----|--|
| C21D 8/1205 | ..  | {involving a particular fabrication or treatment of ingot or slab}                         |
| C21D 8/1211 | ... | {Rapid solidification; Thin strip casting}   |
| C21D 8/1216 | ..  | {the working step(s) being of interest}  |
| C21D 8/1222 | ... | {Hot rolling}  |
| C21D 8/1227 | ... | {Warm rolling}   |
| C21D 8/1233 | ... | {Cold rolling}   |
| C21D 8/1238 | ... | {Flattening; Dressing; Flexing}  |
| C21D 8/1244 | ..  | {the heat treatment(s) being of interest}  |
| C21D 8/125  | ... | {with application of tension}  |
| C21D 8/1255 | ... | {with diffusion of elements, e.g. decarburising, nitriding}                                |
| C21D 8/1261 | ... | {following hot rolling}  |
| C21D 8/1266 | ... | {between cold rolling steps}   |
| C21D 8/1272 | ... | {Final recrystallisation annealing}  |
| C21D 8/1277 | ..  | {involving a particular surface treatment ( <a href="#">C21D 8/1294</a> takes precedence)} |
| C21D 8/1283 | ... | {Application of a separating or insulating coating}  |
| C21D 8/1288 | ... | {Application of a tension-inducing coating}  |
| C21D 8/1294 | ..  | {involving a localized treatment}  |

- C21D 9/00** Heat treatment, e.g. annealing, hardening, quenching, tempering, adapted for particular articles; Furnaces therefor (furnaces in general [E27](#))
- C21D 9/0006 . {Details, accessories not peculiar to any of the following furnaces (control devices [C21D 11/00](#))}
  - C21D 9/0012 . . {Rolls; Roll arrangements}
  - C21D 9/0018 . . {for charging, discharging or manipulation of charge}
  - C21D 9/0025 . . {Supports; Baskets; Containers; Covers}
  - C21D 9/0031 . {Rotary furnaces with horizontal or slightly inclined axis}
  - C21D 9/0037 . {Rotary furnaces with vertical axis; Furnaces with rotating floor}
  - C21D 9/0043 . {Muffle furnaces; Retort furnaces}
  - C21D 9/005 . {Furnaces in which the charge is moving up or down (for wire, strip [C21D 9/54](#))}
  - C21D 9/0056 . {Furnaces through which the charge is moved in a horizontal straight path ([C21D 9/0043](#) takes precedence)}
  - C21D 9/0062 . {Heat-treating apparatus with a cooling or quenching zone}
  - C21D 9/0068 . {for particular articles not mentioned below}
  - C21D 9/0075 . {for rods of limited length (of unlimited length [C21D 9/52](#))}
  - C21D 9/0081 . {for slabs; for billets}
  - C21D 9/0087 . {for chains, for chain links}
  - C21D 9/0093 . {for screws; for bolts}
  - C21D 9/02 . for springs
  - C21D 9/04 . for rails (apparatus for heat treatment of railway rails on the spot [E01B 31/18](#))
  - C21D 9/06 . . with diminished tendency to become wavy
  - C21D 9/08 . for tubular bodies or pipes
  - C21D 9/085 . . {Cooling or quenching}
  - C21D 9/10 . . shotgun barrels
  - C21D 9/12 . . barrels for ordnance
  - C21D 9/14 . . wear- or pressure-resistant pipes
  - C21D 9/16 . for explosive shells
  - C21D 9/18 . for knives, scythes, scissors, or like hand cutting tools
  - C21D 9/20 . for blades for skates

- C21D 9/22 . for drills; for milling cutters; for machine cutting tools
- C21D 9/24 . for saw blades
- C21D 9/26 . for needles; for teeth for card-clothing
- C21D 9/28 . for plain shafts
- C21D 9/30 . for crankshafts; for camshafts
- C21D 9/32 . for gear wheels, worm wheels, or the like
- C21D 9/34 . for tyres; for rims
- C21D 9/36 . for balls; for rollers
- C21D 9/38 . for roll bodies
- C21D 9/40 . for rings; for bearing races
- C21D 9/42 . for armour plate
- C21D 9/44 . for equipment for lining mine shafts, e.g. segments, rings, props
- C21D 9/46 . for sheet metals
- C21D 9/48 .. deep-drawing sheets
- C21D 9/50 . for welded joints
- C21D 9/505 .. {Cooling thereof}
- C21D 9/52 . for wires; for strips; {for rods of unlimited length}
- C21D 9/525 .. {for wire, for rods (C21D 9/54 takes precedence)}
- C21D 9/54 .. Furnaces for treating strips or wire
- C21D 9/56 ... Continuous furnaces for strip or wire
- C21D 9/561 .... {with a controlled atmosphere or vacuum}
- C21D 9/562 .... {Details}
- C21D 9/563 ..... {Rolls; Drums; Roll arrangements}
- C21D 9/564 ..... {Tension control}
- C21D 9/565 ..... {Sealing arrangements}
- C21D 9/567 .... with heating in fluidised beds
- C21D 9/573 .... with cooling
- C21D 9/5732 ..... {of wires; of rods}
- C21D 9/5735 ..... {Details}
- C21D 9/5737 ..... {Rolls; Drums; Roll arrangements}
- C21D 9/58 .... with heating by baths
- C21D 9/60 .... with induction heating

- C21D 9/62 . . . . with direct resistance heating
- C21D 9/63 . . . . the strip being supported by a cushion of gas
- C21D 9/64 . . . Patenting furnaces
- C21D 9/66 . . . Tower-type furnaces
- C21D 9/663 . . . Bell-type furnaces
- C21D 9/665 . . . . inverted or side-facing
- C21D 9/667 . . . . Multi-station furnaces
- C21D 9/67 . . . . adapted for treating the charge in vacuum or special atmosphere
- C21D 9/673 . . . . Details, accessories, or equipment peculiar to bell-type furnaces
- C21D 9/675 . . . . . Arrangements of charging or discharging devices
- C21D 9/677 . . . . . Arrangements of heating devices
- C21D 9/68 . . . Furnace coilers; hot coilers ([cold coilers B21C](#))

- C21D 9/70 . . . Furnaces for ingots, i.e. soaking pits

**C21D 10/00      Modifying the physical properties by methods other than heat treatment or deformation**

- C21D 10/005 . . . {[by laser shock processing](#)}

**C21D 11/00      Process control or regulation for heat treatments ([controlling or regulating in general G05](#))**

- C21D 11/005 . . . {[for cooling](#)}

**C21D 2201/00      Treatment for obtaining particular effects**

- C21D 2201/01 . . . Shape memory effect
- C21D 2201/02 . . . Superplasticity
- C21D 2201/03 . . . Amorphous or microcrystalline structure
- C21D 2201/04 . . . Single or very large crystals
- C21D 2201/05 . . . Grain orientation

**C21D 2211/00      Microstructure comprising significant phases**

- C21D 2211/001 . . . Austenite
- C21D 2211/002 . . . Bainite

- C21D 2211/003 . Cementite
- C21D 2211/004 . Dispersions; Precipitations
- C21D 2211/005 . Ferrite
- C21D 2211/006 . Graphite
- C21D 2211/007 . Ledeburite
- C21D 2211/008 . Martensite
- C21D 2211/009 . Pearlite
  
- C21D 2221/00      Treating localised areas of an article**
- C21D 2221/01 . End parts (e.g. leading, trailing end)
- C21D 2221/02 . Edge parts
- C21D 2221/10 . Differential treatment of inner with respect to outer regions, e.g. core and periphery, respectively
  
- C21D 2241/00      Treatments in a special environment**
- C21D 2241/01 . under pressure
- C21D 2241/02 . . Hot isostatic pressing
- C21D 2241/03 . in zero gravity (e.g. in spce)
  
- C21D 2251/00      Treating composite or clad material**
- C21D 2251/02 . Clad material
- C21D 2251/04 . Welded or brazed overlays
  
- C21D 2261/00      Machining or cutting being involved**
  
- C21D 2281/00      Making use of special physico-chemical means**
- C21D 2281/01 . Seed crystals being used
- C21D 2281/02 . temperature gradient